10/524646

DT05 Rec'd PCT/PTO 17 FEB 2005

IN THE UNITED STATES PATENT AND TRADE MARK OFFICE

VERIFICATION OF TRANSLATION

I, Michael Wallace Richard Turner, Bachelor of Arts, Chartered Patent Attorney, European Patent Attorney, of 1 Horsefair Mews, Romsey, Hampshire SO51 8JG, England, do hereby declare that I am conversant with the English and German languages and that I am a competent translator thereof;

I verify that the attached English translation is a true and correct translation made by me of the attached specification in the German language of International Application PCT/DE03/02612;

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: January 31, 2005

M W R Turner

10/524646
DT05 Rec'd PCT/PTO 17 FEB 2005

Organic component for overvoltage protection and associated circuit

The invention concerns a component of predominantly organic material, which affords overvoltage protection for electronic circuits.

Electronic components for overvoltage protection are known, based on inorganic circuits which are founded on conventional silicon semiconductor technology. Zener diodes and tunnel diodes may be mentioned here by way of example.

Organic electronic components and circuits based thereon are being developed in regard to lowest-cost applications such as RFID-tags (radio frequency identification), tickets, wearable electronics (electronic circuits which are incorporated into textile fabrics) and so forth. They are inexpensive and can be produced over a large surface area by simple printing processes. Those circuits need a constant voltage supply, in which case damage due to voltage peaks, for example if the circuit comes too close to the transmitting antenna or if the RFID-tag is moved too quickly through an alternating electromagnetic field, must be avoided. Hitherto no electronic component is yet known which – comparable to an organic field effect transistor – includes predominantly organic material.

Therefore the object of the present invention is to provide an electronic component which includes predominantly organic material and which affords overvoltage protection, that is to say when the voltage falls below or exceeds an adjustable threshold voltage the component acts as a resistor which interrupts the flow of current and vice-versa, wherein the electrical capacitance of the component is low.

The subject of the invention is an electronic component for overvoltage protection, comprising predominantly organic functional polymers, which component has at least the following layers:

a substrate,

a primary electrode,

an organic semiconducting functional layer, and

a secondary electrode, wherein the threshold voltage can be adjusted by the selection of the electrode materials and/or of the material

for the semiconducting layer. In addition the subject of the invention is a circuit, including at least two components which comprise predominantly organic materials, connected in series for overvoltage protection, wherein the series circuit affords a threshold voltage which corresponds to a multiple of the threshold voltage of the individual components.

In accordance with an embodiment the component includes at least one intermediate layer between one of the electrodes and the organic semiconductor layer. The intermediate layer can be for example predominantly of organic and/or oxidic material. The threshold voltage can be adjusted within some volts by the inclusion of the at least one intermediate layer.

The component is operated in the forward direction, that is to say, up to the threshold voltage no current (or only a negligibly low current) flows, whereas a very high current flows below the threshold voltage so that the voltage of a power-limited current source breaks down. In the reverse direction no current (or only a negligibly low current) flows.

In accordance with an embodiment at least two components are connected in series. In that way it is possible to achieve a desired threshold voltage which corresponds to the multiple of the threshold voltage of the individual components.

The simple structure of the component of conducting and semiconducting layers permits integration into organic circuits. The conducting and/or semiconducting layers can in that case be produced by one process and/or by common process steps, for example printing processes.

The invention is described in greater detail hereinafter by means of embodiments.

Figure 1 shows the simple structure of the component according to the invention without intermediate layers,

Figure 2 shows an embodiment with two intermediate layers,

Figure 3 shows two components connected in series,

Figure 4 shows the corresponding current-voltage curves relating to Figure 3, and

Figure 5 finally shows a component involving a lateral structure.

Figure 1 shows the substrate 1, for example comprising a flexible film such as a polyester film, and disposed thereon (implementation of a vertical structure), the primary electrode 2 which for example is of organic material such as Pani, Pedot or metals or alloys such as gold, copper, aluminum or titanium, disposed thereon the semiconducting layer 3 which is on an organic base of for example polythiophene and/or polyfluorene, and thereon the secondary electrode 4 whose material is again for example Pani, Pedot or a metal or an alloy such as gold, copper, aluminum or titanium. In contrast to conventional components that component has a high threshold voltage which can be adjusted by the selection of the electrode materials and the semiconductor material.

Figure 2 shows a component involving a layer structure comparable to Figure 1 in respect of the layers 2 through 4 and the substrate 1, but in this case disposed between the primary electrode 2 and the semiconducting layer 3 and between the semiconducting layer 3 and the second electrode 4 is a respective intermediate layer (5, 6) by which the threshold voltage can be displaced. The intermediate layers 5, 6 can be of the most widely varying materials, such as for example organic material such as polythiophene, polyfluorene (both materials doped or undoped), Pani, Pedot or an oxidic material such as metal oxide or silicon oxide.

Figure 3 shows two components connected in series, wherein the layer structure in this embodiment is the same as that of the individual component of Figure 1.

Figure 4 shows the current-voltage characteristics of series-connected components. It can be seen in that case how the series connection of a plurality of components (Figure 3) also makes it possible to achieve a threshold voltage corresponding to the multiple of the threshold voltage of an individual component.

Finally Figure 5 shows the lateral structure of a component as is basically known from Figure 1. It is once again possible to see here a substrate 1, a primary electrode 2, a semiconducting layer 3 and a secondary electrode 4.

The threshold voltage can be very well adjusted by the selection of suitable electrodes and/or semiconductor materials. Equally the threshold voltage can be displaced by one or two additional intermediate layers of different semiconductor materials such as for example thin insulating layers or oxides. The series connection of a plurality of components also permits rough adaptation to the respective demands involved.

The capacitance of the component is dependent on the layer thickness and the material-specific dielectric constant of the organic semiconductor. The capacitance can be kept low by means of layers of suitable thickness.

The component is manufactured by means of known processes. The individual layers are applied by sputtering and/or vapor deposition or however when dealing with soluble materials such as for example polymers by spin coating and/or other coating processes and/or printing processes. Structuring can be effected on the one hand by conventional processes such as etching and lift-off in conjunction with lithography or on the other hand by printing procedures.

In specific terms the component, for example as shown in Figure 1, can be produced as follows: a metal layer 2 (for example gold) is sputtered on a flexible polyester film 1 and the metal layer is structured by means of lithography and etching. Then a semiconducting polymer (for example polythiophene) which is put in solution is applied by spin coating. After evaporation of the solvent the result obtained is a homogeneous semiconductor layer 3. A secondary electrode 4 (for example aluminum) is sputtered thereonto – structured by a shadow mask - .

The term 'organic', 'organic material' or 'functional polymer' or 'polymer' includes here all kinds of organic, metallorganic and/or organic-inorganic plastic materials (hybrids), in particular those which are identified in English for example by 'plastics'. This involves all kinds of substances with the exception of the semiconductors which form the conventional diodes (germanium, silicon) and the typical metallic conductors. Restriction in a dogmatic sense to organic material as carbon-bearing material is accordingly not intended, but rather the broad use of for example silicones

is also envisaged. In addition the term is not to be subjected to any restriction in regard to the molecule size, in particular to polymeric and/or oligomeric materials, but the use of small molecules is certainly also possible. The word component 'polymer' in the expression functional polymer is historically governed and in that respect does not make any statement about the presence of an actually polymeric bond.

This invention for the first time provides an organic component which functions as overvoltage protection and which can be integrated into organic circuits.